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ABSTRACT

Two factors which contribute to successful learning are presented and shown to be useful in the selection of teaching methods that match educational aims: a feedback model of the teaching and learning processes based on Pask's conversational learning model; and a classification of educational aims based on Bloom. Several kinds of feedback are listed in descending order of response time: statistical feedback obtained from large surveys of students; assignments; tutorials, telephone conferencing, and self-help groups; and self-assessment questions. A classification of educational achievements is then presented: (1) learning in the affective domain (e.g., attitudes, values, and affective skills such as communication and adaptability); (2) learning in the cognitive domain (e.g., facts and understanding); (3) learning of intellectual skills (e.g., particular techniques, analysis, and synthesis); and (4) learning of manual skills. These categories are explored and illustrated with examples. The selection of teaching media and methods is considered as it relates to their place in the feedback model, their suitability for different educational aims, and their cost-effectiveness. A variety of teaching media and methods is outlined--including face-to-face methods, printed texts, films and television programs, audio, audio-graphic systems, computer-aided learning, laboratory or practical work, and assignments--and a matrix provides guidelines for the selection of methods for various educational aims. Finally, cost-effectiveness considerations of methods and media selection are discussed. (6 references) (GL)

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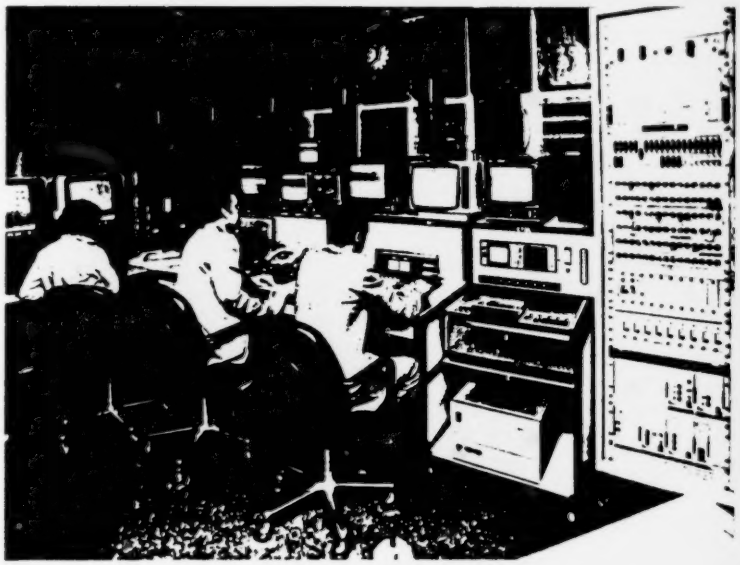
Also lautet ein Beschluß:
Daß der Mensch was lernen muß. —
— Nicht allein das Abc
Bringt den Menschen in die Höh';
Nicht allein im Schreiben, Lesen
Übt sich ein vernünftig Wesen;
Nicht allein in Rechnungssachen
Soll der Mensch sich Mühe machen;
Sondern auch der Weisheit Lehren
Muß man mit Vergnügen hören.
Daß dies mit Verstand geschah,
War Herr Lehrer Lämpel da. —

J. J. Sparkes

On Choosing Teaching Methods to Match Educational Aims



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Zusammenfassung

Sparkes stellt den Lehr-/Lern-Vorgang als Rückkopplungsprozeß dar und differenziert diesen Prozeß hinsichtlich verschiedener formaler Lehr-/Lern-Ziele (affektive Ziele, Fertigkeiten, Wissen, Verstehen usw.).

Er untersucht dann, wie sich die für das Fernstudium relevanten Medien und Methoden in diesem Rückkopplungsprozeß bei den verschiedenen Lernzielen verhalten und leitet daraus eine Bestimmung der Möglichkeiten und Grenzen der verschiedenen Methoden und Medien in Bezug auf die unterschiedlichen formalen Lehrziele ab (vgl. Tab. I, S. 14), die er noch durch eine Schätzung der Kosten der verschiedenen Methoden/Medien ergänzt (vgl. Tab. II, S. 16).

Inhaltsverzeichnis

		Seite
1	Introduction	1
2	Two Aspects of Teaching and Learning	3
2.1	Education as a feedback process	3
2.2	A classification of educational achievements	6
3	Choosing between different teaching methods and techniques	9
3.1	Teaching media and methods	10
3.2	Relating teaching methods to educational aims	11
	Conclusion	17
	References	19

ON CHOOSING TEACHING METHODS TO MATCH EDUCATIONAL AIMS

1 Introduction

Within the fields of teaching and learning it is necessary to make distinctions between different aims and methods, since not all educational aims can be achieved by one style of teaching, and equally, learning by students can take a variety of forms. So the main aim of the following discussion is to present a description of the teaching and learning processes and to draw from it some guide lines on how to enhance the effectiveness of either or both. This can hardly be regarded as a novel aim, since teacher training courses and psychological research have been directed towards it for many years. The complexity of the learning process in human beings has, however, made it necessary for thorough scientific research to be confined to a number of rather specialised topics, with the result that making use of the results of such research in practical teaching situations is not an easy matter.

At the same time, however, it has always been possible for gifted or experienced teachers to bring about successful learning in the class-room even though it is rarely possible to be explicit about how success has been achieved. It has also always been possible for such a teacher to help teacher trainees by example and by coaching. Indeed most complex skills have to be taught mainly in this way, even though verbal or practical instruction must play a key part. With the recent growth of methods of teaching-at-a-distance, however, it has become clear that new teaching abilities are called for and that there are few experts to call upon. Furthermore, the normal process of coaching by which trial-and-error can become trial-and-success with the help of an expert, does not work well with these methods since it occupies so much time. A teaching text, for example, may take weeks to write and more weeks to rewrite. The learning strategy of "practice makes perfect" which may well work with tennis or golf, with piano playing or even with class-room teaching, or lecturing, is very difficult to adopt with such a

teaching method. The same difficulty arises with educational television or with computer-aided instruction. So the development of expertise in the distance teaching environment must be based as much on understanding the capabilities and limitations of each teaching medium - including face-to-face methods - as upon acquired skills.

But if research has not yet reached the stage of prescribing successful methods, the only way to bring about the necessary understanding is to encapsulate and present the knowledge that experience brings in such a way that it can be studied and acted upon by others. This is the basis of the approach adopted in this paper.

Unlike the results of normal scientific research, the knowledge of experience cannot always be tested in controlled experiments. Its sole test may be that it is shared by those with the appropriate experience. Accordingly the distinctions between, say, different educational aims that are made in this paper should be non-controversial in the sense that they should appeal to the "common sense" of teachers, even if scientific evidence is not yet available to confirm them. Hopefully teachers will be inclined to remark that they are well known or even obvious! However, being obvious is not a sufficient condition for acceptability in the present study; it is also necessary that the models and categories discussed clarify courses of action, as to the choice of teaching methods, which would otherwise remain confused. For example, I think it is "obvious" that knowledge (of facts), for any individual, is not the same as understanding; but the distinction would not be worth making in the present context if it did not lead directly to differences in teaching techniques when one or other (or both) are the educational aims being pursued.

Thus the aim of this paper is to describe the teaching and learning activities in common sense terms, using models and categories which are reasonably straightforward but which also map in a fairly clear manner onto the special capabilities of different teaching methods. If this strategy is successful it should lead directly to criteria by which appropriate educational techniques can be chosen to satisfy

particular educational aims.

2 Two Aspects of Teaching and Learning

Of the many factors which contribute to successful learning this paper concentrates on only two. It is, of course, important to ensure that both teachers and students feel at home with the methods being used, and that the students are in reasonably congenial surroundings. It is also the case that different subjects demand different approaches to teaching. But none of these factors is discussed here. The aspects of the teaching and learning activities which are discussed are those that are characteristic of all subjects to a greater or lesser extent. It is assumed that the teaching and learning environments are satisfactory for those involved.

The two aspects discussed are:

(a) a feedback model of the teaching and learning processes; following, but simplifying Pask (1);

(b) a classification of educational aims; following, but simplifying and modifying Bloom (2)

The reason for selecting these two aspects is that they also map well on to characteristics and limitations of different teaching techniques.

2.1 Education as a feedback process

It is a common experience, of teacher and student alike, that both teaching and learning are improved when errors and inadequacies are pointed out and, preferably, dealt with in some way. Equally, both processes benefit when good performance is encouraged. So the importance of such feedback processes in education can hardly be a matter of argument. The following remarks merely encapsulate this idea in a formal model.

Figure 1 illustrates a feedback model of the educational process. It

exemplifies Pask's "conversational" theory since it illustrates that learning is achieved by a continuous iteration between absorbing new information, trying to use it and checking whether it was correctly used. In other words, concepts are recycled through the learning regions of the brain and gradually acquire sufficient richness of meaning for them in the end to be used with confidence to express the learner's own ideas. Such a process applies to learning a language and the meaning of words, to acquiring skills as well as to learning concepts and ideas.

Referring to figure 1, the output of the system is (intended to be) educated students. If the forward path were faultless, and if all students could learn immediately, the output could be achieved without feedback playing a part. In practice, however, the forward path (e.g. written teaching texts, lectures, T.V. programmes, etc) is rarely wholly successful educationally, and in addition, students do not all live up to expectation. So it is necessary to include feedback in the system in order to correct any errors that occur, both in the students' and teachers' performance and to provide "conversational" recycling of ideas.

Several kinds of feedback are possible; they have different characteristics and serve different functions. In descending order of response time these are:

(a) The statistical feedback (shown dashed), obtained from large surveys of student response, indicates whether the forward path is appropriate for the chosen target student population. The time period within which changes to the forward path can be made in response to this kind of feedback is so long that it can normally only affect the next, or next-but-one, cohort of students. It does not, therefore, play any part in the conversational learning process. It is useful only as a means of correcting gross errors in the forward path (e.g. books, lectures, T.V. programmes, etc). It does not, of course, usually specify what was wrong (or right) about the forward path, it merely indicates whether it was good or bad. How to improve matters remains a problem.

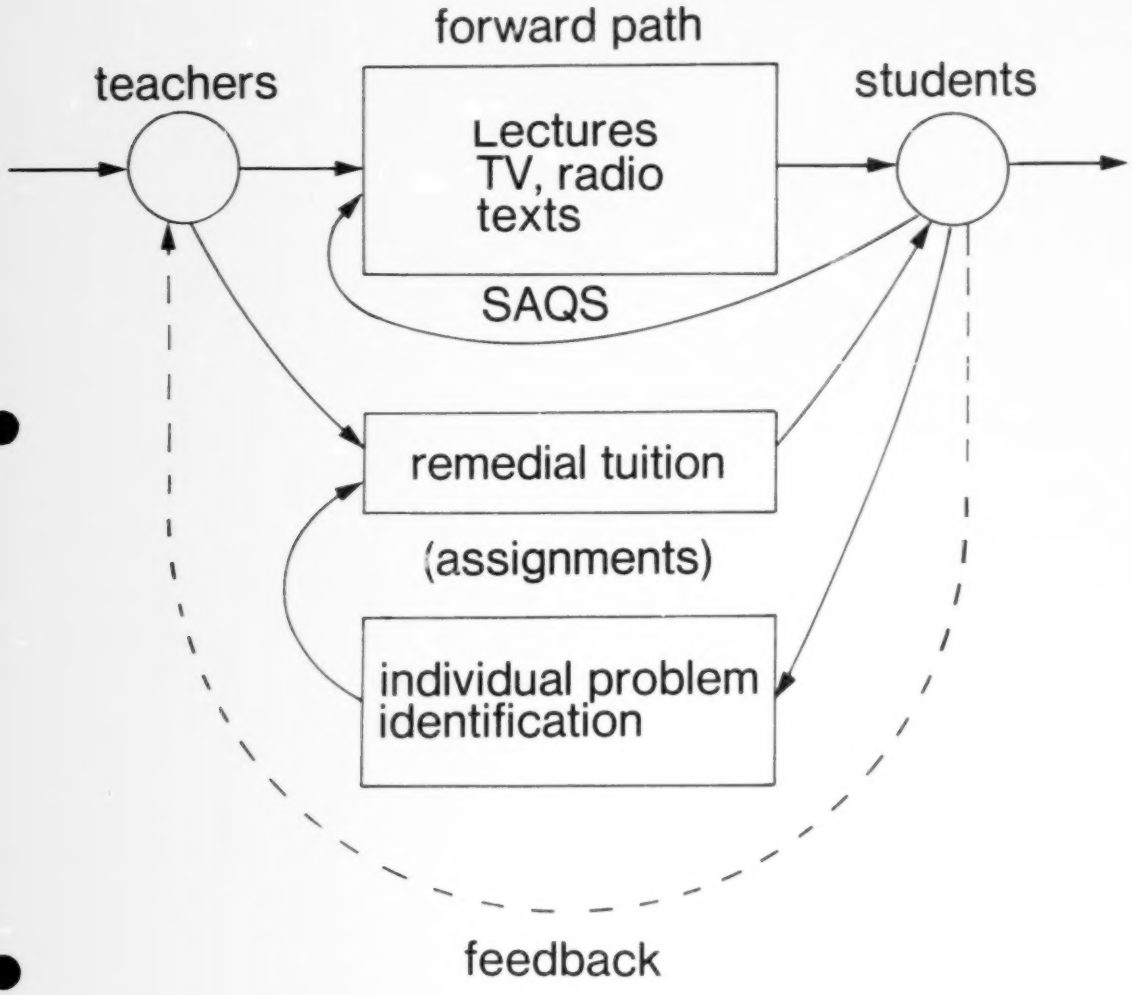

Figure 1. A feedback model of the teaching process.

(b) Assignments have a response time of a few days and provide specific help to each individual student. Computer-marked assignments (CMAs) linked to preprogrammed wordprocessors can provide similar help with certain kinds of topics. To obtain the best educational effects from assignments tutors should give helpful comments on scripts. Assignments can fulfil three different roles: (i) assess a students' performance (and award marks), (ii) correct errors by giving correct or model answers and (iii) encourage further work on the problem so that students will arrive at better performances by their own efforts. As far as effective learning is concerned the last role is generally the most successful.

(c) Tutorials, telephone conferencing and self-help groups provide immediate feedback and true "conversational" learning. A useful distinction can however be drawn between "individual-problem-identification" and "remedial tuition" as shown in the diagram. In tutorials both functions are combined. Computer methods, however, can be used for individual-problem-identification, and various alternative methods can be specified for the provision of remedial teaching (e.g. computer exercises, dial access, telephones, specified face-to-face tutorials, audio-vision, Cyclops, etc). Combining both aspects (problem identification as well as remedial tuition) in face-to-face tutorials is rarely as successful as one would wish.

(d) Self-assessment questions are the simplest stimulant to conversational learning and redirect the student to further study. They also provide a useful check on the effectiveness of the forward path. With the forward path comprising printed or recorded material further study of it is possible. Otherwise students have to seek out alternative educational material.

With small groups a good teacher can provide the several different components of a good conversational education system. In distance teaching, however, it is necessary to pay particular regard to the

whole stystem as well as to particular elements of it; for even a feedback loop tends to be only as effective as its weakest link.

The main purpose of this analysis and of the feedback model is to clarify the roles each teaching component can play, so that where necessary, the continuous conversational process can be kept active and not inadvertently broken by failing to provide a key part to it.

2.2 A classification of educational achievements

It is, of course, well known that there are different kinds of learning. For example, the learning of skills is a very different activity from acquiring knowledge or from embracing a belief in, say, religion or Marxism or apartheid. Yet it is not always apparent that the teaching and learning methods used to achieve these different educational aims take full account of such differences. The purpose of this section, therefore, is to list a range of relatively easily distinguished educational aims (following Bloom in some respects but with much less detail) with a view to arriving at appropriate educational strategies for each kind of educational aim. We shall find, for example, that different educational aims will stress different aspects of the feedback model of education, and will also lay particular emphasis on different teaching techniques.

It should perhaps be stressed that these distinctions are not related directly to subject matter (e.g. athletics, aesthetics, mathematics or engineering) but are concerned more with the kinds of learning that form a part, to varying degrees, of all such topics. There are also differences between academic subjects, and these also have to be taken into account, but these do not form the subject of the present study.

The most useful classes of educational aims, that are both relatively independent of each other and capable of being matched to existing educational techniques, appear to be as follows:

(i) learning in the affective domain;

(a) attitudes, values, etc

(b) affective skills (communication, adaptability, etc)

(ii) learning in the cognitive domain;

(a) of facts

(b) of understanding

(iii) learning of intellectual skills;

(a) of particular techniques

(b) of analysis (e.g. logical, systemic, historical)

(c) of synthesis (e.g. problem solving, design, invention

(iv) learning of manual skills.

These eight categories can be further explained and illustrated as follows:

(i) The affective domain

The affective domain is concerned with values, beliefs, attitudes, predispositions, prejudices, etc. Most people have fundamental beliefs which they are prepared to cling to even if certain items of evidence seem to contradict them. Such evidence can usually be "explained away". To paraphrase Lakatos:(3) "core" theories can be "protected" by layers of auxiliary theories. Thus it is possible to believe in an omnipotent God of love despite the prevalence of evil and hate in the world; or to believe in evolution or creationism despite the contrary evidence about both. Equally "affective skills" such as attention to detail, reliability, flexibility are deep-seated and habitual and one is usually more concerned to explain or justify one's own behaviour than to change it.

Because such core beliefs and habits are so deep-seated and so vehemently and effectively protected, affective education is the most difficult to achieve. Perhaps the most effective external influences are a charismatic teacher, a moving novel or an unforgettable T.V. programme or film. Social pressures are, however,

usually more effective than any formal teaching technique.

(ii) The cognitive domain (a & b)

A simple fact for one person may be very abstruse for another. The facts of a Balance Sheet may be immediately grasped and remembered by an accountant, but may be quite incomphrehensible and unmemorable for someone with no understanding of numbers or of the terminology and conventions that accountants use. Thus, understanding at some level - even if it is of the meanings of everyday words, let along jargon - must precede the learning of facts.

This distinction is particularly important in continuing education. A long undergraduate education in medical understanding is an essential pre-requisite for a factual course in professional medical updating. Undergraduate courses in general are concerned primarily with teaching understanding - supported, of course, with a good deal of information. Understanding usually takes a long time to teach well, but, given the understanding, factual knowledge can be rapidly and easily learnt by interested students. Indeed the verb "to teach" is often reserved for the development of understanding and skills rather than the sharing of facts or opinions.

(iii) Intellectual skills

Intellectual skills are concerned with techniques and methods. Methods tend to require more insight than techniques. Thus it is possible, for example, for someone to have mathematical skills (addition, equation solving, differentiation) with no understanding. Such a person would be said to have been trained in mathematical techniques. On the other hand using mathematical methods to solve a problem requires more than mere techniques. Learning to do so effectively is both an education and a training. It is possible to gain understanding without developing intellectual skills

(indeed such is a common enough complaint about some graduates) but in general the two have to be intermixed to be of use.

Two particular kinds of intellectual skills are those of analysis (the breaking down of a complex problem into manageable parts) and synthesis (the putting together of manageable parts in order to achieve a new complex whole). Universities are mainly concerned with analytical skills (as well as with knowledge and understanding, of course). Synthesis skills are taught and practiced to a much lesser extent than analytical ones, even in such fields as engineering, in which creative design is a key skill. Also in the Arts criticism, rather than creative skills, is given pride of place.

(iv) Manual skills

Manual skills, even typing for computer keyboard operation, are taught very little in universities, though perhaps they should be given more attention. They usually call for relatively little knowledge, understanding or intellectual skills.

3 Choosing between different teaching methods and techniques

Different teaching methods and techniques have differing capabilities and constraints, as regards -

(a) their place in the educational feedback loop of figure 1
(b) their suitability for different educational aims
(c) their suitability to different kinds of subject matter
(d) their suitability for different kinds of students
(e) their suitability for different kinds of teachers
(f) their cost (e.g. per student-hour of effective study).

This paper only considers the first two and the last of these factors.

3.1 Teaching media and methods

The following is a list of different teaching media (or methods) that are at present available or likely soon to be so. All methods require some technology to support them (even if it is just paper and pencil or a blackboard). The level of technology, however, varies very much -

1 Face-to-face (including audio-visual aids)

(a) lectures
(b) classes (as in schools)
(c) small group discussions, usually for remedial purposes
(d) tutorials (i.e. a teacher with no more than 3 students)
(e) self-help groups (i.e. small groups without a teacher)
(f) laboratory or practical work (see 7 below)
(g) the telephone and telephone conferencing

Note: Films, tapes, T.V. programmes, etc., intended for use in face-to-face teaching situations (e.g. in support of a teacher's instruction) are very different from those intended to stand alone, or to be supported by other material such as a printed text.

2 Printed texts

(a) text books
(b) structured tutor-texts (as used in the Open University)

3 Films or T.V. programmes

(a) for broadcasting (i.e. not for repeated replay)
(b) films for T.V. tapes (for repeated replay)

Note: The replay facility which at present is expensive because of the cost of the replay device, should strongly affect the content of such films or tapes, for some educational purposes.

4 Audio

(a) for radio broadcasting
(b) audio tapes
(c) audio-vision (i.e. audio tapes supported by printed illustrations, diagrams, calculations, etc)
(d) telephone conferencing

5 Audio-graphic systems such as Cyclops (i.e. the recording on audio tape of both spoken commentary and of graphic or alpha-numeric data for display on a T.V. screen).

6 Computer-aided learning (CAL)

(a) using teletype terminals
(b) using Visual Display units. Such methods include Prestel, Optel and similar systems
(c) using the mail (for distance teaching) and a word-processor for preparing the communication from the computer

7 Laboratory or practical work

(a) in purpose built teaching laboratories
(b) based on practical apparatus for use in the home or at work
(c) projects

8 Assignments

These can be associated with any of the above, but except in the case of CAL or tutoring they require the use of a further channel of communication.

3.2 Relating teaching methods to educational aims

As pointed out at the beginning of this section the choice between

teaching methods is a multi-dimensional one. Too often in the past a technique such as programmed learning, T.V., or lecturing have been used or commended when one or more of the many factors which make for educational success have been lacking. Consider for example the two forms of face-to-face teaching that are most widely used in universities: the lecture and the small group remedial tutorial.

The lecture is often criticised because it does not teach well (4); it does not compare, for example, with the small group teaching that is normal in sixth forms in schools. But we can now see why this is; lecturing is not a complete teaching method. It is very deficient in the scope it offers for feedback from students to teacher. As a consequence its pace is normally so fast that it leaves little time for more than note-taking, and teacher and students have little opportunity to get to know each other. Conversational learning of the concepts being taught is reduced to a minimum. Indeed no experienced lecturer expects many of his students to have learnt any of the difficult concepts or skills his lecture has dealt with by the end of the lecture; private study, discussion and further reading are normally necessary to complete the learning process.

This does not mean that the lecture should play no part in the teaching process since it can fulfil several roles very effectively. Its primary function in most universities is to present to students an explanatory statement of what should be learnt, and to pace the students' rate of studying. Referring to figure 1, it provides the first forward path (through the student's head) of the concepts to be learned, but it plays little part in ensuring that the concepts will circulate round the learning loop. As a popular and convenient forward path it can be well used to achieve those aims that require little feedback. Thus it is effective as a means of presenting facts (especially recent developments) and practical demonstrations (for example, of calculations, skills or of experiments). A good lecturer can also motivate and enthuse students and so influence their attitudes and values in a variety of ways. Indeed it is often this quality in a lecturer, when it is present, that students appreciate most.

Similar, though different, comments can be made about the use of small group classes or tutorials. Such classes provide what is probably the most effective form of teaching available to us, yet it is common practice not to use it for this purpose (4). It is widely used as means of providing occasional remedial tuition on a particular course, or even on a set of courses; and it is widely regarded as being difficult to manage well if used solely for this purpose. Again, it is clear that in not being used to provide the primary forward path in the teaching process it has been deprived of a key part in the learning process. Indeed, using a group to provide both the "individual problem-identification" and the "remedial tuition" components of the model in figure 1 is bound to be somewhat unsatisfactory since each individual is likely to have a different problem and so to require different remedial help. There are good reasons, therefore, for using different techniques for individual problem identification, such as diagnostic tests, assignments, etc., and for providing individualised remedial help, such as recommended texts, audio tapes on particular topics, encouragement (!), individual classes, either face-to-face or on the telephone or small group classes on particular, specified topics where a need has been identified. But small group teaching is a complete teaching system so it should be reserved for dealing with selected difficult conceptual subjects or skills, the extent to which teachers' time is available.

In the same way it is possible to relate each of the teaching methods listed above to the feedback model and to the set of educational aims listed earlier.

However, there is not sufficient space in an article of this kind to fully explore each possible technique, though it is not difficult to arrive at useful distinctions and guidelines for oneself. Table 1 is a much simplified mapping of educational aims onto educational methods, using different symbols to indicate the part played in the learning feedback process of each method. Circles indicate methods in which the teacher plays the dominant active part and crosses those in which student activity tends to dominate. Where both play a significant role both symbols are used. The number of symbols, on a scale of 0 to 6,

TABLE I

Aim \ Method	Lectures	Small Group Classes	Laboratory or Workshop	Teaching Text	Video Tape	Audio Vision	Broadcast, T.V. and Radio	CAL	Teleconferencing	Home Kit	Dial Access	Projects	Assignments	Self-help Group
1(a) Attitudes	ooo	⊕⊕			oo		ooo ooo		⊕⊕⊕	+++		+++ ++		+++ ++
1(b) Skills		⊕⊕⊕	⊕⊕⊕		ooo				⊕⊕	+++			⊕⊕⊕ ⊕⊕	++
2(a) Knowledge	ooo ooo	⊕⊕⊕		ooo ooo	ooo ooo	ooo	oo oo	+++	⊕⊕⊕	+++	ooo oo			
2(b) Understanding	oo	⊕⊕⊕ ⊕⊕⊕	++ ++	oo oo	oo oo	ooo	oo		⊕⊕⊕	++ ++	ooo	+++	⊕⊕⊕	
3(a) Techniques	o	⊕⊕⊕ ⊕⊕⊕	++	oo oo	o	oo oo		+++ +++	⊕			+	⊕⊕⊕ ⊕⊕⊕	
3(b) Analysis	o	⊕⊕⊕ ⊕⊕⊕		ooo	o	oo		+	⊕⊕ ⊕⊕	+++		⊕++	⊕⊕ ⊕⊕	
3(c) Synthesis		⊕⊕ ⊕⊕		o	o		o	+++	⊕			⊕⊕+ +++	⊕⊕⊕ ⊕⊕⊕	
4 Manual			ooo ooo		oo oo		oo			++		++		

affective domain

cognitive domain

skills

o in which the primary activity is one of teaching by the tutor

\+ in which the primary activity is learning as a result of the students' own initiative

indicates the degree to which a particular method can be expected to contribute to each particular aim. In arriving at the indicated assessment of each method an estimate of costs is also included. That is the relatively expensive methods are regarded as less cost-effective than those of comparable effectiveness but less cost.

The entry under television, for example, indicates that it is, of course, a "forward path" component of the learning loop, in which the teacher is active and the students are passive. The various entries show that its strengths lie in the affective domain and in presenting knowledge. Its weakness in teaching skills lies in the fact that it can only "instruct", it cannot exercise student skills or correct errors. Its weakness in conceptual development stems from the fact that concepts are abstract and so cannot be photographed! However, since television is so rich and flexible, it can make use of both verbal description and visual symbols (as in mathematics) or of visual analogies and simulations even more effectively than a lecturer. The more it uses such techniques for conceptual development, however, the more costly it tends to become and so is regarded as less cost-effective for this purpose than, say, for affective teaching.

Similar reasoning lies behind each entry but, of course, they are only indications of cost-effectiveness and give no more than guidelines as to practical use. They are also subject to modifications according to the subject matter being taught or learnt.

The costs of each teaching method vary greatly both in time and money. A useful measure of the cost in human terms (which can be related quite easily to the cost in monetary terms) is the number of man-hours of teacher time required to produce one student-hour of study. The following are some approximate figures intended only as a guide -

classes (in school)	1.5	tutor-text (as in O.U.)	50.0
lectures	2.0	full O.U. multi-media course	70.0
radio or audio tapes	6.0	CAL	200.0
T.V.	50.0		

These figures indicate the degree of motivation required of an experienced teacher (once the novelty has worn off) if he is to embark on the use of each method.

The actual cost per student of each method depends upon other factors too:

(a) the number of students that are taught as a result of the investment of teacher-time

(b) the proportion of a teacher's time spent on teaching (e.g. in most universities only about 10% of a lecturer's full time appointment (including vacations) is spent on teaching, whereas in schools or in the Open University this figure is nearer 60% though for different reasons)

(c) the number of man-hours of support staff needed per man-hour of teacher-time

(d) the cost of the technology (including the buildings) of each method.

Table II shows some typical approximate, estimated comparative costs - excluding hardware (i.e. (d) above) whose costs are too variable to estimate.

	teacher-hours per student hour (A)	portion of teacher time spent on teaching (B)	number of students per teacher time invested (C)	multiplier to give all staff active per teacher (D)	cost per student $\frac{A}{B}\frac{D}{C}$ (hours/hr)
Classes (school)	1.5	0.6	30	1.1	0.9
Lectures	2.0	0.1	50	1.5	0.5
Full O.U. course	70.0	0.6*	5000	10.0*	0.23
CAL	200.0	0.5	1000	2.0	0.9

Table II

*Open University estimate for a 2nd level course which runs for 8 years. (Includes estimates for administrative and other staff in the University needed to operate the system.)

These figures are again very approximate but they indicate a method of comparing costs between very different teaching systems.

However, costs are only one factor to be considered. Even the cheapest method wastes money if it is educationally ineffective - for whatever reason. A method can be ineffective because students don't like it, because teachers find it too demanding, because of its inherent limitations for the kind of educational aims it is being used for, etc. Thus, although these data give some guidance, they are not the only factors. Indeed there are times when costs are not important and effectiveness is paramount, in which case the data of table II are irrelevant.

Conclusion

The aim of this paper has been to bring together very simple and commonsensical ideas about teaching and learning, so that the know how of experienced teachers, rather than the results of academic research, can be passed on to others. Even the reason for adopting this strategy is based more on experience than research. That is, it can readily be seen that in all complex fields such as economics and other social sciences, management, human relations as well as education, the methodology of scientific research has its drawbacks. Yet it would be difficult to establish through a programme of scientific research that some other methodology would be preferable. The methodology adopted in this paper, therefore, has more in common with "illuminative" methodology of Parlett and Hamilton (5) than with the scientific methods of Popper or Kuhn (6). So the conclusions cannot be said to be well tested or corroborated, though they should be helpful and practical.

One of the main techniques used in scientific research is analysis

and isolation, leading to reductionism and to research programmes on isolated elements of an overall system. A key aim of this paper has been to avoid this kind of analysis and to preserve as far as possible the natural complexity of the educational process. Inevitably, however, some analysis has been necessary. But the elements have been kept as simple as possible, consistent with their being useful and discriminatory. The choice of models and categories has been predicated by two main considerations.

1 Whilst it is certainly true that there will never be clear boundaries between the elements of a complex system, since this is one of the factors which justify the adjective "complex", it is also true that broad, readily perceived categories can usually be identified by experienced people. (Many illustrations of this premiss are to be found; for example, the continuous spectrum of light is readily perceived as distinct colours even though there are no demarcation points; and the more or less continuous and audible signal that we call speech is readily segmented into discrete wc ds, even though the many tiny pauses in the signal do not coincide with the spaces between words; they occur before plosives such as p, d, k, etc).

2 That the purpose of the analysis is to enable the mapping of the categories and the models on to the characteristics of the many teaching methods that are available. For this reason, for example, the categories of subject (e.g. history, biology, mathematics, etc) have not been used since such a mapping does not seem to be very successful as a primary means of choosing between techniques. It can be brought in later to provide finer distinctions if they are needed.

The paper, then, is offered as an attempt to make headway with this methodology. Its success should, I think, be judged in the light of the illumination it brings to teachers and students rather than by the results of any research programmes it may stimulate.

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